Amendments to the Claims

Please amend claims 1, 2, 9, 13, 14, 20, 27, 28, 33-35, 43, 49, 53 and 54. Please cancel claim 5. The Claim Listing below will replace all prior versions of the claims in the application:

Claim Listing

1. (Currently amended)A method for reducing phase error in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub-carriers, the method comprising:

simultaneously rotating the plurality of pilot sub-carriers and the data sub-carrier by an accumulated phase offset associated with a carrier frequency offset between the FDM receiver and the remote source~~, each pilot sub-carrier residing at a respective different frequency~~;

calculating a residual phase offset for each of the plurality of rotated pilot sub-carriers;

determining a mean residual phase offset for the calculated residual phase offsets of the plurality of rotated pilot sub-carriers; and

updating the accumulated phase offset using the mean residual phase offset~~; and rotating the data sub-carrier using the updated accumulated phase offset.~~

2. (Currently amended) The method of claim 1, wherein rotating the plurality of pilot sub-carriers comprises multiplying each pilot sub-carrier by a phasor having an argument including ~~the negative value~~ an inverse of the accumulated phase offset.

3. (Original) The method of claim 1, wherein calculating the residual phase offset comprises calculating a respective arctangent for each of the rotated plurality of pilot sub-carriers.

4. (Original) The method of claim 1, wherein determining the mean residual phase offset comprises fitting a curve to the calculated residual phase offset versus pilot sub-carrier frequency for the plurality of pilot sub-carriers.

5. (Cancel)

6. (Original) The method of claim 4, wherein the fitted curve defines a zero-frequency crossing indicative of the mean residual phase offset.

7. (Original) The method of claim 4, wherein fitting the curve comprises determining a least mean square (LMS) solution.

8. (Original) The method of claim 1, wherein determining a mean residual phase offset comprises applying a threshold discriminator to the plurality of pilot sub-carriers.

9. (Currently Amended) The method of claim 8, wherein applying the threshold discriminator comprises:

determining ~~the~~ magnitude of each of the plurality of pilot sub- carriers;

comparing, for each pilot sub-carrier, the respective determined magnitude to a predetermined threshold magnitude;

using the pilot sub-carrier in determining the mean residual phase offset if the determined magnitude is greater than the predetermined threshold; and

using all of the plurality of pilot sub-carriers, regardless of their respective magnitudes if the determined magnitude of less than two of the plurality of pilot sub-carriers is greater than the predetermined threshold magnitude.

10. (Original) The method of claim 8, further comprising:

detecting sample timing errors; and

adjusting samples of the received FDM symbols responsive to detecting sample timing errors.

11. (Original) The method of claim 10, wherein detecting sample timing errors comprises:
    determining a phase gradient;
    comparing the phase gradient to a predetermined reference phase gradient.

12. (Original) The method of claim 11, wherein adjusting the samples comprises:
    skipping a sample responsive to the comparison indicating the phase gradient is less than the predetermined threshold phase gradient; and
    adding an extra sample responsive to the comparison indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

13. (Currently amended) The method of claim 1, wherein rotating the data sub-carrier comprises multiplying the data sub-carrier by a phasor having an argument including ~~the negative value~~ an inverse of the updated accumulated phase offset.

14. (Currently amended) The method of claim 1, further comprising, prior to rotating the plurality of pilot sub-carriers by the accumulated phase offset, ~~the initial step of selectively,~~ rotating the pilot sub-carriers to a predetermined region.

15. (Original) The method of claim 14, wherein the predetermined region corresponds to the "+1" decision region of a binary-phase-shift-keying (BPSK) constellation.

16. (Original) The method of claim 1, further comprising:
    detecting sample timing errors; and
    adjusting samples of the received FDM symbols responsive to detecting sample timing errors.

17. (Original) The method of claim 16, wherein detecting sample timing errors comprises:
    determining a phase gradient;
    comparing the phase gradient to a predetermined reference phase gradient.

18. (Original) The method of claim 17, wherein adjusting the samples comprises:

    skipping a sample responsive to the comparison indicating the phase gradient is less than the predetermined threshold phase gradient; and

    adding an extra sample responsive to the comparison indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

19. (Original) The method of claim 1, wherein the FDM symbols are orthogonal frequency division multiplexing (OFDM) symbols.

20. (Currently amended) The method of claim 19, wherein the OFDM symbols are defined by a protocol selected from the group consisting of: IEEE 802.11a, IEEE 802.11g, and HYPERLAN/2~~, and combinations thereof~~.

21. (Original) A method for reducing phase error in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub- carriers, the method comprising:

    calculating a phase offset for each of the plurality of pilot sub-carriers;

    applying a threshold discriminator to the plurality of pilot sub-carriers;

    determining a mean phase offset using the threshold discriminated pilot sub-carriers; and

    rotating the data sub-carrier using the determined mean phase offset.

22. (Original) The method of claim 21, wherein applying the threshold discriminator comprises:

    determining a respective magnitude for each of the plurality of pilot sub-carriers;

    comparing, for each pilot sub-carrier, the respective determined magnitude to a predetermined threshold magnitude;

    using the pilot sub-carrier in determining the mean phase offset if the determined magnitude is greater than the predetermined threshold; and

using all of the plurality of pilot sub-carriers, regardless of their respective magnitudes if the determined magnitude of less than two of the plurality of pilot sub-carriers is greater than the predetermined threshold magnitude.

23. (Original) The method of claim 22, wherein the predetermined threshold is approximately 1/32.

24. (Original) The method of claim 22, further comprising:

detecting sample timing errors; and

adjusting samples of the received FDM symbols responsive to detecting sample timing errors.

25. (Original) The method of claim 24, wherein detecting sample timing errors comprises:

determining a phase gradient;

comparing the phase gradient to a predetermined reference phase gradient.

26. (Original) The method of claim 25, wherein adjusting the samples comprises:

skipping a sample responsive to the comparison indicating the phase gradient is less than the predetermined threshold phase gradient; and

adding an extra sample responsive to the comparison indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

27. (Currently amended) The method of claim 21, wherein the FDM symbols are orthogonal frequency division multiplexing (OFDM) symbols.

28. (Currently amended) The method of claim 27, wherein the OFDM symbols are defined by a protocol selected from the group consisting of: IEEE 802.11a, IEEE 802.11g, and HYPERLAN/2~~, and combinations thereof~~.

29. (Original) A method for reducing sample timing errors in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub-carriers, the method comprising:

    calculating a phase offset for each of the plurality of pilot sub-carriers;

    calculating a phase gradient using the calculated phase offsets, the phase gradient representative of the change in phase versus frequency for the plurality of pilot sub-carriers;

    comparing the calculated phase gradient to a predetermined threshold phase gradient; and

    adjusting samples of the FDM symbol responsive to the comparison of the calculated phase gradient to the predetermined threshold phase gradient.

30. (Original) The method of claim 29, wherein adjusting samples comprises:

    skipping a sample responsive to the comparison indicating the phase gradient is less than the predetermined threshold phase gradient; and

    adding an extra sample responsive to the comparison indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

31. (Original) The method of claim 29, wherein the reference phase gradient is related to a sample period.

32. (Original) The method of claim 29, wherein the FDM symbols are orthogonal frequency division multiplexing (OFDM) symbols.

33. (Currently amended) The method of claim 32, wherein the OFDM symbols are defined by a protocol selected from the group consisting of: IEEE 802.11a, IEEE 802.11g, <u>and</u> HYPERLAN/2~~, and combinations thereof~~.

34. (Currently amended)An apparatus for correcting phase error in a pilot-based, frequency-division- multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub-carriers, comprising:

an accumulator storing an accumulated phase offset associated with a carrier frequency offset between the FDM receiver and the remote source;

a first multiplier continuously coupled to the accumulator, the multiplier receiving a plurality of pilot sub-carriers and ~~multiplying~~ rotating the plurality of pilot sub-carriers by the accumulated phase offset;

a phase error processor coupled to the first multiplier and the accumulator, to calculat~~eing~~ a residual phase offset for each of the plurality of rotated pilot sub- carriers, to determin~~eing~~ a mean residual phase offset for the calculated residual phase offsets of the plurality of rotated pilot sub-carriers, and to provid~~eing~~ the ~~calculated~~ mean residual offset to the accumulator~~, storing~~ for updating the accumulated phase offset~~ using the mean residual phase offset~~; and

a second multiplier continuously coupled to the accumulator, the second multiplier receiving the data sub-carrier and ~~multiplying~~ rotating the data sub-carrier by the ~~updated~~ accumulated phase offset.

35. (Currently amended) The apparatus of claim 34, wherein multiplier receives from the accumulator, a phasor having an argument including ~~the negative value~~ an inverse of the accumulated phase offset.

36. (Original) The apparatus of claim 34, wherein phase error processor includes an arctangent function for calculating the residual phase offset for each of the rotated plurality of pilot sub-carriers.

37. (Original) The apparatus of claim 34, wherein phase error processor comprises a curve fitting function to the calculated residual phase offset versus pilot sub-carrier frequency for each of the plurality of pilot sub-carriers, the fitted curve defining a slope indicative

of the phase gradient versus frequency and a zero-frequency crossing indicative of the mean residual phase offset.

38. (Original) The apparatus of claim 37, wherein a curve fitting function comprises a least mean square (LMS) function.

39. (Original) The apparatus of claim 34, further comprising a threshold discriminator determining the magnitude of each of the plurality of pilot sub-carriers, comparing the determined magnitude to a predetermined threshold magnitude, and selectively using the pilot sub-carrier to determine the mean residual phase offset if the determined magnitude is greater than the predetermined threshold, and using all of the plurality of pilot sub-carriers, regardless of their respective magnitudes, if the determined magnitude of less than two of the plurality of pilot sub-carriers is greater than the predetermined threshold magnitude.

40. (Original) The apparatus of claim 39, further comprising a comparator coupled to the phase error processor and a syncyronizer, coupled to the first and second multipliers, the comparator comparing a phase gradient to a reference phase gradient threshold and providing an output signal indicative of a timing error to adjust samples of the received FDM symbols.

41. (Original) The apparatus of claim 40, wherein the synchronizer skips a sample responsive to the comparator output signal indicating that the phase gradient less than the predetermined threshold phase gradient, and adds an extra sample responsive to the comparator output signal indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

42. (Original) The apparatus of claim 34, wherein the FDM symbols are orthogonal frequency division multiplexing (OFDM) symbols.

43. (Currently amended) The apparatus of claim 42, wherein the OFDM symbols are defined by a protocol selected from the group consisting of: IEEE 802.11a, IEEE 802.11g, and HYPERLAN/2, ~~, and combinations thereof~~.

44. (Original) An apparatus for reducing phase error in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub- carriers, comprising:

a phase error processor receiving the plurality of pilot sub-carriers and calculating a respective phase offset for each;

the phase error processor comprising:

a threshold discriminator receiving the calculated phase offsets;

a mean function determining the mean phase offset using the threshold discriminated pilot sub-carriers; and

a multiplier coupled to the phase error processor, multiplying the received data sub-carrier by a phasor having an argument related to the determined mean phase offset.

45. (Original) The apparatus of claim 44, wherein the threshold discriminator comprises:

a magnitude detector, detecting a magnitude for each of the plurality of pilot sub-carriers; and

a comparator, comparing the respective determined magnitude of each of the plurality of pilot sub-carriers to a predetermined threshold magnitude, the comparator using the pilot sub-carrier in determining the mean phase offset if the determined magnitude is greater than the predetermined threshold, and using all of the plurality of pilot sub- carriers, regardless of their respective magnitudes if the determined magnitude of less than two of the plurality of pilot sub-carriers is greater than the predetermined threshold magnitude.

46. (Original) The apparatus of claim 44, further comprising a comparator coupled to the phase error processor and receiving a reference phase gradient threshold, the comparator

providing an output signal to the synchronizer responsive to the results of the comparison indicative of sample timing errors.

47. (Original) The apparatus of claim 46, wherein the synchronizer skips a sample responsive to receiving an output signal from the comparator indicating the phase gradient is less than the predetermined threshold phase gradient; and adds an extra sample responsive to receiving an output signal from the comparator indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

48. (Original) The apparatus of claim 44, wherein the FDM symbols are orthogonal frequency division multiplexing (OFDM) symbols.

49. (Currently amended)The apparatus of claim 48, wherein the OFDM symbols are defined by a protocol selected from the group consisting of: IEEE 802.11a, IEEE 802.11g, and HYPERLAN/2~~, and combinations thereof~~.

50. (Original) An apparatus for reducing sample timing errors in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub- carrier and a plurality of pilot sub-carriers, comprising:

a phase error processor, calculating a phase offset for each of the plurality of pilot sub-carriers and a phase gradient using the calculated phase offsets, the phase gradient representative of the change in phase versus frequency for the plurality of pilot sub-carriers;

a comparator coupled to the phase error processor comparing the calculated phase gradient to a predetermined threshold phase gradient; and

a synchronizer coupled to the comparator, adjusting samples of the FDM symbol responsive to the comparison of the calculated phase gradient to the predetermined threshold phase gradient.

51. (Original) The apparatus of claim 50, wherein the synchronizer skips a sample responsive to the comparison indicating the phase gradient is less than the predetermined threshold phase gradient; and

adds an extra sample responsive to the comparison indicating the phase gradient is greater than and/or equal to the predetermined threshold phase gradient.

52. (Original) The apparatus of claim 50, wherein the FDM symbols are orthogonal frequency division multiplexing (OFDM) symbols.

53. (Currently Amended) The apparatus of claim 50, wherein the OFDM symbols are defined by a protocol selected from the group consisting of: IEEE 802.11a, IEEE 802.11g, and HYPERLAN/2~~, and combinations thereof~~.

54. (Currently amended)A system for reducing phase error in a pilot-based, frequency-division- multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub-carriers, the method comprising:

means for simultaneously rotating the plurality of pilot sub-carriers and the data sub-carrier by ~~an~~ current accumulated phase offset associated with a carrier frequency offset between the FDM receiver and the remote source~~, each pilot sub-carrier residing at a respective different frequency~~;

means for calculating a residual phase offset for each of the plurality of rotated pilot sub-carriers;

means for determining a mean residual phase offset for the calculated residual phase offsets of the plurality of rotated pilot sub-carriers; and

means for the current accumulated phase offset using the mean residual phase offset~~; and~~.

~~means for rotating the data sub-carrier using the updated accumulated phase offset.~~

55. (Original) A system for reducing phase error in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub- carriers, the method comprising:

means for calculating a phase offset for each of the plurality of pilot sub- carriers;

means for applying a threshold discriminator to the plurality of pilot sub- carriers;

means for determining a mean phase offset using the threshold discriminated pilot sub-carriers; and

means for rotating the data sub-carrier using the determined mean phase offset.

56. (Original) A system for reducing sample timing errors in a pilot-based, frequency-division-multiplexing (FDM) receiver configured to receive FDM symbols from a remote source, each symbol including a data sub-carrier and a plurality of pilot sub-carriers, the method comprising:

means for calculating a phase offset for each of the plurality of pilot sub- carriers;

means for calculating a phase gradient using the calculated phase offsets, the phase gradient representative of the change in phase versus frequency for the plurality of pilot sub-carriers;

means for comparing the calculated phase gradient to a predetermined threshold phase gradient; and

means for adjusting samples of the FDM symbol responsive to the comparison of the calculated phase gradient to the predetermined threshold phase gradient.